

## ChemTalk

### THE STRUCTURE OF MATTER

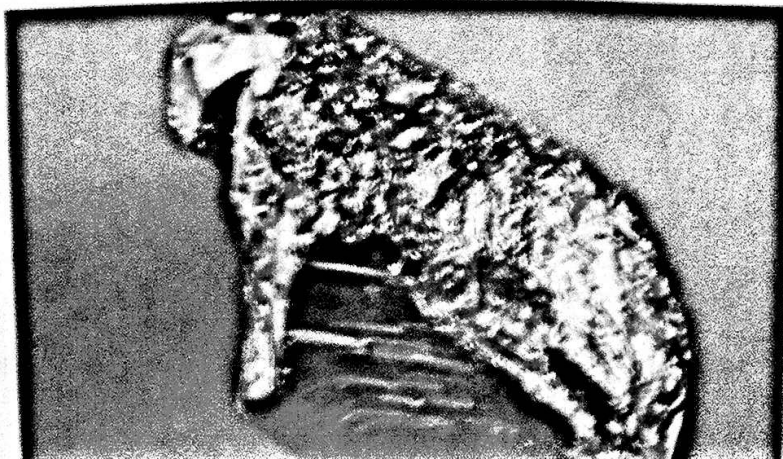
In this investigation you used electricity to decompose water into two gases. You knew that the gases were different because they reacted differently to the burning and glowing splints. Since water is referred to as  $\text{H}_2\text{O}$ , a first guess would be that hydrogen (H) and oxygen (O) were created in the experiment. The test for hydrogen is a small explosion when exposed to a burning splint. The test for oxygen is igniting a glowing splint. If you look back on the results of the experiment, you find that the hydrogen gas filled one test tube while the oxygen filled half of the other test tube. There was twice as much hydrogen as oxygen. That's where the 2 comes from in the chemical formula  $\text{H}_2\text{O}$ .

Hydrogen and oxygen are elements. An **element** is any material that cannot be broken down into simpler materials by chemical means.

You are probably familiar with many elements like hydrogen, oxygen, zinc, gold, or helium. Other elements like strontium and beryllium are more exotic and less likely to be familiar to you. Every kind of matter you observe in your everyday life is made up of the chemical elements. There are only about a hundred different kinds of chemical elements. This is an amazing discovery of chemistry — everything you observe in the world is made of different combinations of a hundred elements. Chemistry is the study of how these elements combine and the characteristics of these combinations.

#### Chem Words

**element:** is any material that cannot be broken down into simpler materials by chemical means.



Elements are represented by symbols. The symbol is one, two, or three letters that represent the name. It's easier to write O than to write oxygen. It's easier to write H than to write hydrogen. The symbols come from many different sources. However, the same symbols are used for each element in all countries of the world.



### Symbols for Some Elements

Name of Element	Symbol
aluminium	Al
bromine	Br
calcium	Ca
carbon	C
chlorine	Cl
copper	Cu
gold	Au
helium	He
hydrogen	H
iodine	I
iron	Fe
lead	Pb
magnesium	Mg
mercury	Hg
neon	Ne
nickel	Ni
nitrogen	N
oxygen	O
phosphorus	P
potassium	K
silicon	Si
sodium	Na
sulfur	S
tin	Sn
zinc	Zn



When elements combine they form new substances called **compounds**. These compounds have entirely new characteristics. It is like combining the letters of the alphabet to make words. Twenty-six letters can be combined to make thousands of different words.

Water is an example of a compound. A water molecule,  $\text{H}_2\text{O}$ , is composed of two atoms of hydrogen and one atom of oxygen. (For now, think of an atom as the smallest particle of an element and a molecule as the smallest unit of a compound.) In this activity you used electricity to decompose water into its elements, hydrogen and oxygen. This process is called **electrolysis**. You observed that oxygen gas made a glowing splint burst into flame, and that hydrogen gas was explosive. However, to extinguish a burning splint, you could use liquid water. The compound has very different characteristics from the elements from which it is made.

Compounds are represented by **chemical formulas**. A chemical formula shows the symbols of the elements that are combined to make the compound. If there is more than one atom of an element, a subscript is added after the symbol indicating how many atoms of that element there are. For example, as you discovered in this activity, the chemical formula for water is  $\text{H}_2\text{O}$ .

### Chem Words

**compound:** a material that consists of two or more elements united together in definite proportion.

**electrolysis:** the conduction of electricity through a solution that contains ions or through a molten ionic compound that will induce chemical change.

**chemical formula:** the combination of the symbols of the elements in a definite numerical proportion used to represent molecules, compounds, radicals, ions, etc.

### Examples of Some Chemical Formulas

Compound	Common Name	Chemical Formula
calcium carbonate	chalk	$\text{CaCO}_3$
carbon dioxide	dry ice	$\text{CO}_2$
hydrochloric acid	muriatic acid	$\text{HCl}$
hydrogen sulfide	rotten-egg gas	$\text{H}_2\text{S}$
sodium hydrogen carbonate (or sodium bicarbonate)	baking soda	$\text{NaHCO}_3$
sodium chloride	table salt	$\text{NaCl}$
sodium nitrate	fertilizer	$\text{NaNO}_3$
sulfuric acid	battery acid	$\text{H}_2\text{SO}_4$





## Active Chemistry Movie Special Effects

From the table of chemical formulas, you can see that carbon dioxide is a compound of carbon and oxygen. There are two atoms of oxygen for every atom of carbon. Sodium hydrogen carbonate (sodium bicarbonate) is a compound of sodium, hydrogen, carbon, and oxygen. There are three atoms of oxygen for every atom of the other elements. Also, there are a total of three atoms in the carbon dioxide formula and a total of six atoms in sodium hydrogen carbonate.

To generate the gas to fill the empty eggshell in this activity (the teacher demonstration), zinc was placed in hydrochloric acid. Zinc is an element. Hydrochloric acid (HCl) is a compound of hydrogen and chlorine. The reaction of the zinc and hydrochloric acid created a gas. Given the explosion you observed, you can guess that the gas produced was hydrogen. The hydrogen gas came from the hydrogen in the hydrochloric acid.

There's much more to the structure of matter than you can discover in just one activity. However, this activity may have raised some new questions in your mind. For example:

- Can all compounds be decomposed into their elements?
- What techniques can be used to decompose compounds?
- What are elements made of?
- What are atoms?
- What are molecules?

These questions and many more will be explored in other *Active Chemistry* activities.

### Checking Up

1. In your own words, explain the difference between an element and a compound.
2. Why are symbols useful in describing chemical elements?
3. What are the symbols for the following elements: carbon, copper, gold, and helium?
4. What information does a chemical formula of a compound provide?

## Reflecting on the Activity and the Challenge

Part of the problem you are facing in creating a special effect is understanding what matter is made of and how it can change. In this activity you broke a chemical compound down into its component elements using electrolysis.

hundred elements, but there are many thousand compounds. You should begin thinking of ways in which some of the reactions you observe could be made to appear more dramatic.